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The prevalence of airflow obstruction in rural primary care

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Summary Spirometry has been reported to be under-utilized, and airflow obstruction may be under-diagnosed, in primary care practice.
Study objectives: The objective of this study was to determine the prevalence and severity of airflow obstruction in rural primary care settings and the degree to which it can be predicted by clinical characteristics. Spirometry was performed in patients 35 years and older who had smoked, presenting for any reason to one of eight rural primary care practices. Obstruction was defined as an $FEV_1/FVC < 0.70$. A total of 1046 subjects were recruited of whom 1034 had acceptable and reproducible spirometry. Airflow obstruction was detected in 17.4% (180 patients). Of those with obstruction, 77.2% (SE 3.1%) had at least one respiratory symptom versus 62.4% (SE 1.6%) without obstruction ($P = 0.0002$). Only 44.9% (SE 3.7%) of those with airflow obstruction had been previously diagnosed with obstructive lung disease. Of those with an $FEV_1 < 50\%$ of predicted, 85% (SE 5.6%) were breathless on exertion; however, only 63% (SE 7.6%) were being treated with respiratory medications. We conclude that airflow obstruction is common in rural primary care practice and cannot be accurately predicted by symptoms. It is undiagnosed half of the time, and often not treated even when symptomatic.

Introduction

Mild-to-moderate airflow obstruction, defined by spirometry, is present in approximately 25% of adult smokers.[1] Evidence suggests that it is under-diagnosed.[2–4] One reason for under diagnosis is that spirometry, the gold standard diagnostic tool, is underutilized in clinical practice.[5] Unfortunately,

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the presence or absence of clinical findings is not accurate to detect airflow obstruction.[4] Increased use of spirometry in the clinical setting has been repeatedly recommended over the years[6,7] with perhaps the strongest statement coming from the National Lung Health Education Program in the US recommending: 'the widespread use of office spirometry by primary-care providers for patients 45 years or older who smoke cigarettes'.[5]

Surprisingly, despite the calls for screening spirometry in the primary care setting, there exist few studies about how much additional clinical information spirometry imparts in this situation.[8,9] To address this, we identified eight rural primary care practices that previously had not had convenient access to spirometry. Spirometry was carried out in these practices on patients who were at least 35 years of age, had ever smoked, and who presented for any reason to their primary care physicians.

The objective of this study was to determine the prevalence and severity of airflow obstruction in rural primary care settings and the degree to which it can be predicted by clinical characteristics. We describe the prevalence of detected airflow obstruction by severity, by symptoms, by previous clinical diagnosis, and by prior treatment.

Methods

Geographic location: Primary care practices were recruited from rural Eastern Ontario, Canada. They had to be within a 2-h driving distance of The Ottawa Hospital, which allowed the hospital-based research assistants to drive to the practices each day to perform spirometry. The practices could not have spirometry on-site, or within the community, in order to avoid contamination of results of clinical diagnosis. Several rural communities were selected to assess variability between practices. The practices were sent letters of invitation and then telephoned. The first eight that agreed were included in the study.

Subjects: Eligible subjects were all patients presenting to their primary care practitioners for any reason, who were at least 35 years of age, and who had smoked at least 20 packages of cigarettes in their lifetime. The patients were given a brief questionnaire by the clinic receptionist that determined their age, smoking history, and asked whether they would agree to participate. Those patients who were eligible, and agreed to participate, were approached by the research assistant and signed informed consent. Patients who could not perform spirometry were excluded. The study was approved by The Ottawa Hospital Human Ethics Committee.

Baseline data collection: Interviewer-administered questionnaires included questions about smoking, respiratory symptoms, and diagnosed respiratory illnesses taken from the American Thoracic Society (ATS) Questionnaire[10] which has been standardized and tested for reliability.

Spirometry was performed in the practice building by trained research assistants using a Microlab 3500®. Tests were performed according to the American Thoracic Society criteria. Testing was done with the subjects seated and a maximum forced exhalation was carried out for a minimum of 6 s. A minimum of three and a maximum of eight forced vital capacity (FVC) maneuvers were performed to obtain at least three acceptable loops, two of which were reproducible within 200 ml. The reference values used were those of Knudson et al.[11] All spirometry tests were reviewed by an independent senior cardiopulmonary technologist and two respirologists to ensure acceptability. If the FEV_1 was less than 80% or if the FEV_1/FVC was <0.7, then spirometry was repeated 20 min after two inhalations of salbutamol (Ventolin®) from a metered dose inhaler administered via a spacer (Aerochamber®).

Statistical analysis

The criterion for prevalence of airflow obstruction was a pre-bronchodilator FEV_1/FVC less than 0.7. Results were also stratified by severity based on the FEV_1. The χ^2 statistic was used to test associations between prevalence and risk factors: age, gender, smoking, and respiratory symptoms. To determine the prevalence of new diagnoses of airflow obstruction the presence of obstruction was stratified by the presence or absence of reported physician-diagnosed asthma, COPD, emphysema or chronic bronchitis. Homogeneity of variance between practices was tested prior to pooling the results.

Results

The population of the eight communities ranged between 1206 and 4406. Each practice was composed of 1–7 participating physicians. A total of 1046 subjects were recruited into the study, of whom 1034 had acceptable and reproducible spirometry. One hundred and eighty patients (17.4%) had airflow obstruction, defined as a

Table 1 Characteristics of study population stratified by of the presence or absence of obstruction.

Characteristics	Total cohort	$FEV_1/FVC < 70\%$ $n = 180$	$FEV_1/FVC \geqslant 70\%$ $n = 854$	*P*-value for group differences
Age—mean (SD)	59.1 (12.7)	66.1 (12.3)	57.7 (12.3)	0.0001
Female *n* (%)	482 (46.6)	58 (32.2)	424 (49.7)	<0.0001
Post-secondary education *n* (%)	250 (24.5)	39 (22.0)	211 (25.1)	0.3951
Smoking history—mean (SD)				
Years of smoking	29.6 (14.1)	38.2 (14.5)	27.8 (13.4)	<0.0001
Pack years of smoking	35.5 (28.5)	48.3 (29.2)	32.8 (27.6)	<0.0001
Symptoms *n* (%)				
Shortness of breath	482 (46.7)	106 (59.2)	376 (44.0)	0.0002
Cough	227 (22.0)	61 (33.9)	166 (19.5)	<0.0001
Phlegm	221 (21.4)	56 (31.1)	165 (19.3)	0.0005
Wheeze	425 (41.1)	102 (56.7)	323 (37.8)	<0.0001
Any of the symptoms	672 (65.0)	139 (77.2)	533 (62.4)	0.0002
Disease *n* (%)				
Asthma	152 (14.8)	45 (25.3)	107 (12.6)	<0.0001
COPD	35 (3.4)	19 (10.7)	16 (1.9)	<0.0001
Emphysema	32 (3.1)	22 (12.4)	10 (1.2)	<0.0001
Chronic bronchitis	150 (14.8)	35 (20.0)	115 (13.7)	0.0319
Any of the diseases	271 (26.5)	79 (44.9)	192 (22.7)	<0.0001
Medication *n* (%)	195 (18.9)	68 (37.8)	127 (14.9)	<0.0001

pre-bronchodilator $FEV_1/FVC < 0.70$ (Table 1). There was no significant difference in prevalence of airflow obstruction between the 8 sites (χ^2 $P = 0.17$). The mean age of the study patients was 59 year (95% CI, 58–60) with patient's having a mean 30 year history of smoking (95% CI, 27–29). Nineteen percent of patients in the study (95% CI, 17–21) were taking respiratory medications (defined as use of inhaled bronchodilators, inhaled corticosteroids, or theophyline compounds). Physician-diagnosed obstructive respiratory diseases such as asthma, COPD, emphysema, and/or chronic bronchitis were reported in 26.5% (95% CI, 23–30%) of the total cohort respectively (Table 1).

To determine the degree to which the study group was representative of all eligible subjects, the entire clinical population that visited the eight primary care practices was surveyed for several days. Of these 1800 subjects who were 100% sampled, 561 were at least 35 years of age and had ever smoked. Compared to all of those eligible (age at least 35 year and had ever smoked), the group studied with spirometry differed as follows: 2 years younger in age, 1% more males, and 1 year more smoking.

Compared to those without obstruction, the obstructed group was 8 years older with 9 more years of smoking ($P = 0.0001$ for each difference) (Table 1). Obstruction was present in 30% of those over 65 years of age and in 10% of patients younger than 40. Of those with airflow obstruction, 77.2% (SE 3.1%) had at least one respiratory symptom (dyspnea, chronic cough, chronic sputum production, or wheeze) versus 62.4% (SE 1.6%) of those without airflow obstruction ($P = 0.0002$). 44.9% (SE 3.7%) of those obstructed reported a physician-diagnosis of asthma, COPD, emphysema, or chronic bronchitis versus 22.7% (SE 1.2%) of those without obstruction ($P = 0.0001$). Use of a respiratory medication was twice as common in those with obstruction versus those without obstruction (Table 1).

The obstructed group was stratified by severity based on the % predicted FEV_1 and patient characteristics were tested for trend across the subgroups (Table 2). Although men were more likely to be obstructed than women (Table 1), gender was not associated with increasing disease severity (Table 2). Of the respiratory symptoms, breathlessness was significantly associated with increasing severity of airflow obstruction ($P = 0.0001$ for trend), as was cough ($P = 0.04$). The presence of phlegm or wheeze was not significantly associated with increasing severity of airflow obstruction.

Table 2 Characteristics of subjects with an $FEV_1/FVC < 70\%$ stratified by severity of obstruction.

Characteristics	$FEV_1 \geqslant 80$ $n = 35$	$80 > FEV_1 \geqslant 50$ $n = 105$	$FEV1 < 50$ $n = 40$	*P*-value for trend
Age—mean (SD)	64.7 (12.9)	65.2 (12.5)	69.8 (10.3)	0.0740
Female *n* (%)	10 (28.6)	37 (35.2)	11 (27.5)	0.8799
Post-secondary education *n* (%)	9 (26.5)	22 (21.4)	8 (20.0)	0.5143
Smoking history—mean (SD)				
Years of smoking	34.6 (14.4)	37.3 (15.3)	43.9 (10.6)	0.0057
Pack-years of smoking	43.9 (25.8)	46.7 (31.3)	56.5 (25.1)	0.0646
Symptoms *n* (%)				
Shortness of breath	14 (40.0)	58 (55.8)	34 (85.0)	<0.0001
Cough	10 (28.6)	31 (29.5)	20 (50.0)	0.0426
Phlegm	9 (25.7)	30 (28.6)	17 (42.5)	0.1076
Wheeze	17 (48.6)	59 (56.2)	26 (65.0)	0.1504
Any of the symptoms	23 (65.7)	79 (75.2)	37 (92.5)	0.0052
Disease *n* (%)				
Asthma	6 (17.1)	28 (26.9)	11 (28.2)	0.2857
COPD	0	10 (9.6)	9 (23.1)	0.0012
Emphysema	1 (2.9)	10 (9.6)	11 (29.0)	0.0006
Chronic bronchitis	3 (8.6)	20 (19.6)	12 (31.6)	0.0139
Any of the diseases	9 (25.7)	43 (42.2)	27 (69.2)	0.0002
Medication *n* (%)	6 (17.1)	37 (35.2)	25 (62.5)	<0.0001

Table 3 Prevalence of airflow obstruction, an $FEV_1/FVC < 70\%$ by quartiles of pack-years smoking history.

	Pack-years of smoking (quartiles)			
	<15.5 ($n = 254$)	15.5 to <31.0 ($n = 250$)	31.0 to <48 ($n = 261$)	⩾48 ($n = 259$)
$FEV_1/FVC < 0.7$	$n = 20$, 7.8%	$n = 24$, 9.6%	$n = 55$, 21.1%	$n = 80$, 30.9%

Increased severity of obstruction was associated with a previous history of physician-diagnosed COPD ($P = 0.0012$) and emphysema ($P < 0.001$), but not asthma.

Respiratory medications were more likely to be prescribed in more severe cases of airflow obstruction. However, only 62.5% of those patients with an $FEV_1 < 50\%$ were being prescribed respiratory medications despite the observation that 85% had at least grade-2 dyspnea based on the Medical Research Council dyspnea scale (breathless hurrying on the level or walking up a slight hill).

Cumulative smoking history was expressed in pack-years, the number of years smoked multiplied by the number of cigarettes daily divided by 20. Categorized into quartiles, there was a fourfold increase in prevalence of obstruction, 7.9% v. 30.1%, from the lowest quartile (<15.5 pack-years) to the highest (⩾48.0 pack-years), $P < 0.0001$ (Table 3).

Those who were not obstructed were not given a bronchodilator. Of those who were obstructed and administered a bronchodilator,163 remained obstructed. The number who had a $FEV/FVC > 0.7$ prebronchodilator was 854 which increased to 884 postbronchodilator. The prevalence of airflow obstruction was 17.4% prebronchodilator and 13.1% postbronchodilator. Thirty-eight percent of those whose FEV_1/FVC ratio was <0.70 pre-bronchodilator were taking respiratory medications versus 44% of those whose FEV_1/FVC ratio remained <0.70 post-bronchodilator. Respective values for the percentage with any respiratory symptoms were 77% and 82%.

Discussion

Spirometry has often been recommended in primary care but apart from a study in China by

Takahashi et al. it has never been examined in this setting. This study provided a unique insight into the prevalence of obstruction in rural practices, which are known to be under-serviced by spirometry when compared to larger cities.[12] The results of this study suggest that airflow obstruction is common in rural primary care practice and cannot be accurately predicted by symptoms. It is undiagnosed half of the time, and is often not treated even when symptomatic. Apart from a history of a previous diagnosis and management, pack-years smoking was the strongest predictor, with a four-fold increase between the lowest and highest quartiles, i.e. <16 and $\geqslant 48$ pack-years years.

A 100% sampling of the practices indicated that the study group was representative of these primary care practice populations. The 100% sampling also indicated that 1/3 of the entire clinic population was eligible for the study based on age at least 35 years and having ever smoked.

A potential limitation of this study is that a very simple definition of obstruction was selected, FEV_1/FVC $<70\%$. This would bias the results in the older population towards being obstructed since the FEV_1/FVC ratio falls with age. However, one ratio applied to all ages is what is recommended by the ATS and GOLD guidelines to diagnose obstructive lung disease and this ratio serves as a simple rule-of-thumb convenient for the primary care setting.

Similar studies of the prevalence of airflow obstruction in rural primary care practices could not be found, but there have been previous population- based and volunteer studies. Buist et al.[1] screened 73,694 cigarette smokers, aged 35–60 years, for participation in the Chronic Obstructive Lung Disease Early Intervention Trial (Lung Health Study). The sample was very large but not a representative sample, since subjects were recruited through the media, mail-outs and screening in public places and work-sites. Smoking was defined as having smoked at least 10 cigarettes in 1 day during the last 30 days. Twenty-five percent of the subjects were found to have mild-to-moderate airflow obstruction defined as an FEV_1/FVC ratio of $<70\%$ and an FEV_1 between 55% and 90% of predicted using the reference values of Crapo et al.[13] Renwick and Connolly[4] mailed a questionnaire to 893 subjects at least 45 years of age who were registered with 22 local general practices in Central Manchester. Characteristics of the 723 respondents were: mean age of 66 years, 57% women, 29% current smokers, and 37% ex-smokers. Of the 240 patients who underwent spirometry in the Renwick study, 26% had airflow obstruction defined by an FEV_1/FVC $<65\%$. Our study differs from the Renwick study in that we studied patients presenting to their primary care office, the patients' mean age was 7 years younger (59 years), and the communities were in rural areas, rather than in a highly industrialized area such as Manchester, UK. Pack years was not described by Renwick et al. In our study, it made a large difference. The prevalence of airflow obstruction in the lowest quartile (<15.5 pack-years) as 7.9% v 30.9% in those highest quartile ($\geqslant 48$ pack-years).

Recently Lundback et al.[14] reported that 14.5% of ex-smokers and 24.6% of current smokers had an FEV_1/FVC ratio less than 70% among 1237 community-based subjects in Northern Sweden. Differences seen between studies in the prevalence of airflow obstruction may potentially be explained by differences in: age, gender, socioeconomic status, smoking, and air pollution exposure amongst the populations studied. Additionally, differences in the spirometric definition of obstruction, and the choice of reference values, can also explain differences found between studies.

Takahashi et al. reported the first clinic-based with two groups of people in two different settings. One group was current and ex-smokers at least 40 years old, and the second group symptomatic patients with no previous diagnosis of respiratory disease. The two settings were hospital-based and general-practice-based primary care settings. Seventy-six percent of the subjects were men, with a mean age of 63 years, and the FEV_1/FVC was <0.7 in 27%. Bronchodilators were not given. Study results were not presented stratified by setting and patient group making it hard to compare with the results of the present study.[8]

Recently, Buffels et al.,[9] reported that office spirometry detected obstruction in 18% (126/703) of patients between 35 and 75 years old with reported cough, wheeze, breathlessness, or nasal allergy or hay fever. Airflow obstruction was detected in 4% (9/222) without complaints. Obstruction was defined as an FEV_1/FVC $<88.5\%$ of the predicted value for men and $<89.3\%$ for women. They concluded that a questionnaire did not accurately categorize those with spirometry-defined obstruction.

Airflow obstruction cannot be accurately diagnosed without spirometry. We found that obstruction was more common among those who were older, had smoked more, had symptoms or diagnoses of respiratory disease, and amongst those who were taking respiratory medications. However, of these characteristics, only physician-diagnosis of respiratory disease and use of respiratory medications were at least twice as prevalent in

the obstructed compared to the non-obstructed group.

Airflow obstruction is under-recognized and under-treated. Approximately half of those with airflow obstruction were not diagnosed, and half of those with symptoms were not treated. However, airflow obstruction is also sometimes over-diagnosed. Ten percent of those with diagnosed COPD or emphysema had both a normal FEV_1 and a normal FEV_1/FVC.

Based on this primary care study, is screening spirometry indicated in rural physicians' offices? Spirometry as a screening tool for lung disease meets many of the criteria desirable in screening.[15] The disease under consideration for screening should be a major medical problem whose natural history is understood, and accepted medical treatments should be available and accessible. Asthma and COPD are major medical problems with predictable natural histories, and accepted medical treatments are available, such as smoking cessation, vaccination, exercise, and medications. Furthermore, spirometry is a relatively simple, inexpensive, and accurate screening test that could be made easily available in primary care practices. Based on these criteria, spirometric screening for obstructive lung disease is desirable, and may improve quality of care in primary care practice.

These results support the use of screening spirometry in primary care practice, but there are several questions that need to be answered to better understand the health impact. Will physicians act on the spirometric findings, will patients adhere to recommendations, and how much will this influence health outcomes? Is spirometry best done on-site or referred to a central community laboratory? Who should interpret the results? Nevertheless, the results of this study demonstrate that spirometry, guided by simple screening criteria easily applied in primary care, can detect a significant number of cases of airflow obstruction, many of which have gone undiagnosed, and many of which are symptomatic yet untreated. Therefore, spirometry in rural clinical practice has the potential to improve diagnostic accuracy and therapy for obstructive lung diseases.

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